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Agro-food farmland Environmental Monitoring Techniques and Equipment

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Abstract

In recent years, caused by farmland environment for agro-food safety events and sudden public events are gradually increase the situation. The current China agro-food environmental situation is far from optimistic. In this paper, new, fast and efficient farmland environment technology and instrument equipment already become this field of important scientific and technological requirements. Based on the comprehensive literatures, and on the basis of research achievements, combinative oneself from fast detection techniques of pesticide residues, heavy metal pollution fast detection techniques, and agro-food quality fast detection techniques, space monitoring technology, farmland environmental monitoring agricultural informatization. This paper expounds the agricultural aspects involved farmland environmental monitoring the related technologies and equipment, summarizes the China agro-food farmland environmental monitoring technology and equipment, and puts forward the advantage and shortage on computer technology as the foundation's future agro-food farmland environmental quality monitoring techniques and equipment information development new direction

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1. Introduction

The quality and safety of agro-food, and directly related to human health is farmland environmental quality and safety of agro-food, the basis of farmland soil, irrigation, livestock shed and freshwater fish water environment as the main elements of farmland environmental of agro-food, whatever the number of quality and safety of security or has important significance[1]. Due to the industrialization, the urbanization and the influence of intensive agriculture itself, by farmland environmental pollution, the increasingly serious crop and breeding animals suffer, even affect the health of consumers. In recent years, caused by farmland conditions for farm produce safety events, and sudden public events is gradually

increasing trend. The current China agro-food farmland environmental situation is far from optimistic, for example the agro-environment monitoring system for 14 provincial capital city 2110 a sample test indicated, vegetables of pesticide, heavy metal and nitrite respectively pollution exceeds bid as 31.1%, 23.5% and 12.1%[2]. According to the pollution control, monitoring first principle, this field in agricultural environmental protection and improving agricultural productivity, agricultural and food security and discipline construction of monitoring technology and equipment, there is a huge demand. Therefore, solving agricultural pollution, produce quality control should be extended to farmland environmental pollutants control and agricultural ecological environment protection, starting from the source from the environment and agricultural pollution problem solving. Among them, the agro-food farmland environmental quality monitoring is an important agricultural farmland environmental overall control and prevention based work, and while farmland environmental quality of advanced agro-food with monitoring equipment monitoring technology is play a decisive role..

Farmland conditions is the basis of quality and safety of agro-food, farmland soil, irrigation, livestock shed and freshwater fish water environment as the main elements of farmland environmental of agro-food, whatever the number of quality and safety of security or has important significance. Over the past 20 years, with industrialization, urbanization, agricultural intensification process accelerating, industrial wastewater and life sewage discharge and chemical fertilizers, inferior quality and unreasonable application of precipitation, atmospheric pollutants farmland environment, especially suburban farmland poses a grave threat to the environment. Heavy metal, chemical pesticide residues in such pollutants in farmland soil environment, the influence is endangering quality and safety of agro-food, and even endanger human body health; Methane and ammonia, feather, dust etc of harmful substances in shed accumulate in the environment can cause livestock disease, which affects the quality of livestock and poultry products; Freshwater aquaculture environment water acidification, eutrophication, algae breeding, chemical pollution factors lead to aquatic products quality drop, even harm of consumer health. Therefore, understanding, farmland environmental science reasonable evaluation scrape farmland environmental pollution factor, to protect agricultural ecological environment, improve agricultural production level, ensure agricultural product quality and quantity security has an important meaning, and will form remarkable economic social benefits.

This paper mainly discusses the current domestic and foreign agro-food farmland environmental quality monitoring techniques and monitoring equipment development present situation and the trend of independent innovation, and domestic agro-food farmland environmental quality monitoring equipment research front and development direction, in order to monitor the quality and safety of agricultural development direction of the whole construction and thought to provide useful basis.

2. The traditional agro-food farmland environmental monitoring techniques

Environmental monitoring technology including sampling technique, analysis technology, data processing technology. Environment pollution monitoring have a lot of do by chemical analysis. Instrument analysis instrument analysis instrument analysis of coupled methods are widely used, such as gas chromatography-mass spectrometry (gc-ms) meter, liquid chromatography-mass spectrometry, gas chromatography coupled, atomic absorption spectrometry inductively coupled plasma spectrometry (gc-ms), etc. Coupled techniques in environmental monitoring complementarity, show the excellent performance.

The current agro-food farmland environmental mostly monitoring method of testing field application in traditional analysis technology and equipments, and forming no independent special technology system. The traditional agro-food farmland environmental monitoring technology there exist many limitations. As to the soil heavy metal detection need complex pretreatment, large-scale testing instrument and skilled

technical staff, high cost (a single sample testing takes all the indicators nearly thousand yuan RMB) and require longer (3~5 days); A whole index aquaculture water quality inspection also need 2~4 days and nearly thousand yuan RMB cost. These enable mass farmland environmental quality screening difficult to implement.

3. . Fast detection techniques in agro-food farmland environmental monitoring application

Agro-food of various kinds, involve wide, only on conventional large chemical analysis detection instrument can't meet the testing field complex environment and fast detection needs. Fast detection techniques, as a new fast detection method has become an important food safety inspection tools. In recent years, fast detection techniques have developed in daily monitoring field soon, which played more and more important role. In testing department daily inspection work in, because big sample, can first test with fast detection method after screening, and found a specific problem analysis and detection of agricultural garnish with qualitative and quantitative analysis instrument, which can save a lot of human, material and financial resources. Relative to traditional chemical testing and instrument testing, the main characteristic is rapid detection instrument choiceness easy for carrying, testing need small sample, procedures simply and quickly, testing results intuitive clear and detection of low cost, to detect environmental conditions of demand is not high.

Fast detection techniques in agro-food farmland environmental monitoring mainly embodied in the application of agro-food, production quality, pesticide residues, heavy metal content, PAHs residue and aspects of agro-food farmland identification.

3.1. Pesticide residue fast detection techniques

Pesticide residue fast detection techniques can be divided into chemical testing and biochemical tests and biological detection three categories. These three more research in a instrument analysis, this enzyme inhibition method, biological sensors method, immune analysis, living assay etc.

Currently used for rapid detection of pesticide residue method mainly enzyme-linked immunosorbent method (ELISA) and enzyme inhibition method (EM)[3]. In developed countries, this enzyme inhibition method and enzyme-linked immunosorbent method to detect pesticide residue kit or dipsticks are pesticide residues of field survey and the field test basic method. Many company specializes in immuosorbent or dipsticks development and application, almost all the important pesticide varieties have corresponding residue detection kit. Wang Yafei[4] Heilongjiang August First Land Reclamation University such as enzyme inhibition method using plant ester, using lysine - two chlorine b indigo phenolic for colour-display reagent, through the UV-2802PCS type uv-vis spectrophotometer, it is concluded that vegetables than color of organophosphorus pesticide multi-residues in vegetables, which established the rapid organophosphorus pesticide residue detection methods. China Agricultural University of pesticide already preparation out several specific antibodies, antigen and antibody preparation technology also basic mature.

This enzyme inhibition method is Chinese rapid detection of pesticide residue technology application most technology. Use this principle to produce the various rapid detector, speed measuring cards are increasingly enter all vegetable's base, wholesale market, even super market has become Chinese rapid detection of pesticide residue mainstream technology[5]. For example, Luan Yunxia[6] applications such as Beijing Research Center for Agrifood Testing and Farmland monitoring, the Beijing agricultural information technology research center, the Beijing Meika technology Co., LTD. jointly developed for portable detector fruit and vegetable pollutants three-in-one nitrite, heavy metal lead and pesticide samples were measured and food safety 2120V- FT Optizen rapid detector. The results showed that the

instrument compared to nitrite, heavy metal lead, pesticide each index all have the better detection accuracy and precision, and can satisfy the requirements of rapid detection. The wide application of enzyme inhibition method for the field detection, become instrument analysis obvious progress effectively complement, but instrument function and enzyme performance need further improvement. According to the pesticide residue all use instrument measurement speed is different, the standard of the judgment different circumstance, ministry of agriculture shall have organized a partial speed measuring devices comparative experiments, make various instrument testing results comparable, and will promote the use of performance is good products, to promote the rapid detector in pesticide residues.

3.2. Fast detection techniques of heavy metal pollution

Along with fertilizers, pesticides and sewage inappropriate use of any irrigation, agro-food farmland environmental pollution condition increasingly serious. Beijing use urban sewage and industrial wastewater irrigation field for 30 to 40 years of history, at present the same area of nearly 15 thousand hm^2 , mainly concentrated in the south-eastern Tongzhou-Chaoyang district, in the west Fangshan-Shijingshan district. In 2002, the Beijing municipal bureau of agriculture investigation and test results show that Beijing counties vegetable farmland soil quality situation is better, and suburban some vegetables base environment problem is more serious, Chaoyang district Shibaidian, Fengtai district the Lugouqiao and Changxindian of soil vegetables base far beyond the mercury content of soil environmental quality standard of secondary standard limits[7]. As the suburbs industrialization and urbanization rapid development, more and more farmland there is pollution hazard. Therefore, farmland environmental quality of agro-food timely and effective monitoring management is particularly important.

Heavy metal pollution is also the main factors of influence of agro-food safety. At present is more research abroad enzyme inhibition detection techniques and immunology testing technology. But the technology is still in a stage of study, without the authentication. In heavy metal residues fast detection method, mostly use chemical, enzyme sensors and immune analysis technology research. Italy DMA-80 Milestone company directly measured mercury apparatus can determine solid and liquid mercury in content and don't need to sample pretreatment, each sample analysis instrument can finish in 5min, detect limit is 0.05 ng level[8]. The agro-environment protection monitoring such as scientific research Xu Yingming[9] by dipping method will have special effects chromogenic reaction biological colorings notice to the preparation of the heavy metal, labels, the rapid immunochromatographic assay for heavy metal labels have good selectivity and reproducibility. In agro-food the technology had filled in farmland environmental field heavy metal fast detection techniques lacunae. At present, this equipment has in Tianjin and Shouguang City, Shandong Province vegetable base applied in food safety inspection, and satisfactory results were obtained.

America led an X-ray screening and early heavy metal instrument listed as standard methods of qualitative analysis. Lu Anxiang[10] applications XRF7 type portable energy dispersive X-ray fluorescence analyzer (National Engineering Research Center for Information Technology in Agriculture, the Beijing purkinje general instrument Co., LTD. Jointly developed the heavy metal elements in soil) Cu, Zn, Cr, Pb and As testing, the results showed that the soil particle impact test precision, major effect of soil water content characteristic peak is strong, and verified portable X-ray fluorescence spectrum testing soil heavy metal elements have relatively good accuracy and precision, suitable for rapid detection of heavy metals in soil.

Li Wei[11] using partial least squares and artificial neural networks respectively established to predict the way black soil alkali-hydro nitrogen content of near infrared spectral analysis model, the results show that the artificial neural network method established correction model partial least squares are superior to the built model, because the near infrared spectra and sample constituents content has certain nonlinear

relation between, and the neural network has prominent nonlinear mapping capability. Xie Xianli[12] analysis such as nine metals (copper, lead, zinc, cadmium, cobalt, nickel, iron, manganese and chromium) and soil visible light of near infrared spectral reflectance a correlation between their reasons. Study found in soil for acquisition of differential spectrum information, and using heavy metal element can significantly improve the combined band is of relevance..

3.3. Agro-food quality fast detection techniques

The United States department of agriculture instrument laboratory in the early 1960s using near-infrared technology determination of grain moisture, protein, fat and other content of near infrared spectral technology, in agricultural and sideline products widely used in the analysis[13]. In China, this technology application quite late, China agricultural university Wen Ming[14,15], developed the LED lighting portable NIR integrated wheat ingredients measuring instrument and maize quality analyzer, the NIR using artificial neural network model of linear model, the result of better outcomes, the measuring instrument can be in grain depot on the entire field site even non-destructive testing ingredients wheat. Zheng Jianrong[16] developed filter reflex NIR test device for fluidized bed spray granulation process real-time monitoring particle water content test and the simulation results show that using the near infrared test analysis technology and eight of near infrared beams with high moisture detection device, the measurement precision and anti-jamming, to realize products grain moisture automatic measurement and control provides a new method. Kawamura[17], using the grating spectroscopy construct milk quality of on-line detection system, the individual cow milk quality on-line detection, mainly detection indicators are fat, protein, lactose, body cell number, milk urea nitrogen, and applications of partial least squares (PLS) method to establish the model of each test index.

Zou Bing[18] use spectral analysis technology, developed a used to forecast the chlorophyll content greenhouse tomato crop growing new equipment. Experiment shows that development of crop growing instrument easy operation, low cost, flexibility is good, precision is higher, it has higher application value. Zou Xiaobo[19] support by near infrared, such as machine vision, combining electronic nose three detector for nondestructive testing Fuji apple, one of the detector is used to measure the content of apple, while two other local apple's color, measuring detector in size, shape and fruit, and combining the attribute information such as these information using artificial neural network and multivariate linear regression etc algorithm to improve the overall quality appraisal apple local and the accuracy and the simulation results show that this device to measure apple, compared with sugar content of near infrared detector measurement using alone by 17%, false positives reduced to 6%. Tianjin university carried out Zhao Youquan[20] ascertainment of chlorophyll fluorescence detection technology and instrument research, chlorophyll fluorescence detection instrument is developed, and through the field experiment tracking monitoring the water body of professional in Spring and Summer into the distribution of phytoplankton content, the growth and the effects of climate change, and the two scales from time and space are analyzed to verify the such testing technology and research the reliability of the instrument and practical.

3.4. Space monitoring technology

Remote sensing monitoring technology is a kind of large space scale nondestructive testing technology. Remote sensing monitoring is a physical method, mathematical method and geological analysis based on comprehensive application technology, with the macro, comprehensive and dynamic and fast characteristic[21]. Along with the development of remote sensing technology, some scholars study explores the origin of remote sensing technology in the environmental monitoring application of agro-

food[22]. Remote sensing technology advantage lies in different periods can accurately record the history of terrain and environment condition and change, through comparing, can objectively extraction nature of your goals, distribution number and space position, based on this information, you can find the resources and environment change district and metabolic trend, thus condition for the agro-food farmland environmental protection policy formulation provided scientific basis. Agriculture Information remote sensing monitoring, we can utilize multi-resolution of satellite remote sensing data from different aspects and angle monitoring crop growth and change. In the process of dynamic remote-sensing monitoring, gathered a lot of foundation material, produced all kinds of results data.

Liu Zhongyang[23] used in 1982, 1992 and 2002 climate data, NDVI data and DEM data fusion of multi-source data, non-supervised classification. After classification, processing, spatial analysis and data mining, it is concluded that the Yellow Huaihai region after 1982 to 2002 vegetation variation. Nie Yong[24] use 1976, 1988 and 2006 land satellite remote sensing data phase, using object-oriented interpretation method combined with expert knowledge classification rules national nature reserve automatic extraction Everest three periods glaciers, and using remote sensing information, geographical information system and mapping method of spatial and temporal distribution characteristics and change glacier and its reason and uncertainty is analyzed. Results show that the 1976-2006, Everest reserves continued contribution of shrinking glacier, obviously has expanded quickly.

Using existing environmental monitoring network and regular monitoring method and the remote sensing technology and ground monitoring method of combining the establishment of environmental pollution, remote sensing monitoring system, will greatly promote agricultural farmland environmental remote sensing monitoring technology in the development of our country. Air and water pollution, acid rain, climate change, ozone depletion and so on a series of environmental problems not only is our country is facing serious problems around the world. A lot of environmental remote sensing practice experience shows that developing agro-food farmland environmental remote sensing technology will directly contribute to the development of agro-food farmland quality inspection, and bring huge economic benefits and social benefits.

3.5. Agro-food and intelligence information farmland environmental monitoring and visualization

Information and communication technology rapid development and foreign successful application practice to establish a uniform agro-food farmland environmental monitoring and intelligence information platform to provide the possibility. Internet of Things, this is called sensor network computer, Internet and the mobile network once again after the information industry of tide. Things in agro-food farmland environmental monitoring network, including the application of irrigation, monitoring crops, livestock air changes of soil environmental conditions and large areas of the surface monitoring, collect temperature, humidity, wind, atmosphere, rainfall, related land humidity, nitrogen concentrated volume and soil pH value, thereby scientifically forecast disaster mitigation, help farmers, scientific planting, and improving the agricultural comprehensive benefit.

For example, Purdue university on, Albert, j. Heber[25] developed farmland air quality such as computer monitoring system for monitoring site farmland pollutant concentration, air exchange, weather conditions, building status, in 13 states were built 29 farmland air quality monitoring system, processing field computer more than 3.0 billion data sample.

In recent years, as agriculture industrialization process accelerated ceaselessly, some special techniques and equipment began to appear. Such as Beijing research center information technology in agricultural development of farmland environmental management system software[26].

4. Discuss

Currently, Chinese agro-food farmland environmental monitoring field is mainly exist in the following aspects: (1) lose not clear, location is passive. In planning layout edible agricultural base or park construction, due to lack of farmland environmental census data, some important origin, or even green foods and organic agricultural base also exist pollution phenomenon; (2) Monitoring methods are backward, and in the "point" the high cost of sampling and survey data, users often unbearable, and because the sampling density, representative of poor, according to statistical laws of the urgent need to provide "face-like" interpolation data; (3) Decision, as shown in the timeliness poor old, slow data update a soil survey time-consuming, the urgent need to introduce information quickly get technology; (4) Resource sharing is poor, performance data visualization and sharing in the low degree of existing paper, that data in the form of "shelved", the urgent need to use visualization technology improve the data utilization efficiency; (5) Mechanism, performance in poor explanatory data dig and mechanism research is not, agriculture model and ecological model high degree of links, cannot reflect the agricultural farmland area conditions the temporal and spatial distribution and trends.

Agro-food farmland environmental monitoring field can be applied some technology has been in production practice, some other technology, while still in the exploration, but it is an optimistic application prospect. From the technical point of view, our agro-food farmland environmental monitoring technology and equipment gap with developed countries, the key technology and equipment needed for scientific and technological innovation, the development of low-cost rapid monitoring new methods, new standards and new equipment. From the application perspective, no matter from the application from farmland environmental figuring scrape or pollution-free, green, organic agricultural base location construction, all need low cost, quick, convenient farmland environmental monitoring technology and equipment.

5. Conclusions

Samsoe- Peterson[27] through survey 75 pieces such as different degree of contaminated soil and its production of agro-food, found that different kinds of pollution agro-food the sensitive degree of different. Research shows that rice to the absorption of heavy metals in soil than wheat high degree of 30%, and vegetables PAHs pollution absorption relatively less; Be like again, excessive amounts of nitrogen fertilizer of farmland will cause vegetables, but nitrate content exceeds bid to planting flowers will not exist such problems. Different agricultural land use type of environmental quality requirements, are not uniform environmental quality standards, copying, will cause the waste of resources and financial resources. This needs us in view of the different agro-food, based on the growth of plants and absorption mechanism provides feature method of soil environmental value make reasonable the analysis judgment, and give appropriate suitability assessment, achieve agricultural the optimized allocation of land resource and reasonable use.

‘11th five-year plan’ period, national support research in the field of modern agricultural technology in agro-food, quality inspection technology and equipment, and other aspects of the research progress achieved important and remarkable social and economic benefit, but also for ‘11th five-year plan’ period undertaking agro-food farmland environment monitoring technology and equipment research and laid a good foundation.

The current non-destructive testing technology for a single product most testing, and a project to produce a variety of internal quality of comprehensive study much[28]. Test methods Realizing the goal online nondestructive testing technology, a variety of sensor fusion technology to improve Chinese agro-food, farmland environmental monitoring techniques and equipment, enhance the ability to participate in international competition, reducing the workload, and has important theoretical significance and practical significance, and can create higher social benefits and economic benefits. Therefore, the future of Chinese

agro-food farmland in the environmental monitoring technology and equipment should be toward the direction:

(1) In paying the premise of inspection equipment costs, the accurate, fast comprehensive detection method and testing means research;

(2) further strengthening agro-food farmland environmental monitoring new technology and new equipment, adopt independent development and study of the way of the combination of the overseas introduction;

(3) should strengthen the multispectral technology and machine vision technology, acoustic properties testing, nuclear magnetic resonance (NMR) technology, X-ray imaging, agricultural dielectric properties combined testing technology research;

(4) should carry on the multiple sensor information integration technology research;

(5) combined networking technology, establish a uniform agro-food farmland environmental monitoring and intelligence information platform.

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